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ABSTRACT

Studied were eye coordination and effects of fatigue on vision in the visual and academic functioning of 1049 students in grades 1 through 10. An earlier study (1966) examined the eye coordination of 1152 students in grades 1 through 12. The common Snellen Test of Visual Acuity failed to indicate 42% of students who were diagnosed by other tests to have eye problems. Tests of eye coordination tendencies found students to be either orthophoric (perfect eye coordination), exophoric (laterally divergent) hyperphoric (vertically divergent), or esophoric (laterally over-convergent). Orthophoric students tended to be the youngest in their classes, to be good readers, and to cost less to educate. Esophoric students were poor readers, the oldest in their classes, and the most expensive to educate. Welfare students with esophoric eye coordination tested lower on IQ and reading than their esophoric non-welfare classmates. It is recommended that each child receive a clinical vision check early in his school life. (DB)

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Final Report

Project No. 2-J-042
Contract No. OEC-X-72-0023(057)

THE EFFECT OF EYE FATIGUE ON READING, BASED ON TEST SCORES AND THE PRESENCE OF DEVIANT EYE COORDINATION, EITHER ESOPHORIA, EXOPHORIA OR HYPERPHORIA

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APRIL 1973

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July 1973

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

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Appreciation is expressed for those contributors who made this study possible:

To Dr. William Baldwin, whose insights into optometry and public education made possible the first full vision screening with the Modified Clinical Technique of an entire school district in Oregon. His leadership and advice reduced many school learning difficulties. Dr. Baldwin is now Dean, Massachusetts College of Optometry, Boston.

To Dr. Richard Septon, Director of Clinics, Pacific University, who in 1966 directed forty-two doctoral candidates in vision screening 1147 students. In 1972-73, as assistant dean, he served as project consultant and proof reader of this paper for technical correctness.

To school Superintendents Claude Martin, John McRae and Orville Bailey for their supporting insight, leadership and patience.

To Mrs. Gary Sather, guidance para-professional, who in the 1971-1972 school year tested 1049 students for near and far acuity, orthophoria, esophoria, exophoria and hyperphoria in an effort to improve learning. Without her work major observations, comparisons and conclusions would not have been possible.

To the many others whose interest, advice and labor were vital to this study goes a heartfelt "Thank you".

ABSTRACT

For many years the drop out rate of Oregon students hovered around the 20% point. The main cause was their inability to read the high school textbooks or the tests which partly determined their promotion. Some were given remedial reading as a second chance but very seldom were they given an adequate analysis and correction of their basic difficulties.

This study investigates the effect of tiring in the majority of students whose eyes pass the standard acuity test, yet require some special effort to coordinate on the same target at textbook reading distance.

The vision screening usually done for students reveals only one component of sight, that of visual acuity at 20 feet. This practice appears to deny 42% of visually handicapped students the recognition and support they need for better reading ability. Doctoral candidates tested 1152 Neah Kah Nie students, 99% white Americans, in grades 1-12 with the modified clinical vision screening technique. Of the students found with some vision difficulty the acuity test revealed 58% but failed to indicate 42% who were found by other tests and observations.

The girls of 14 classrooms in two schools had been screened and referred on the basis of acuity alone. They needed further study because they were not achieving as well as the boys when I.Q. was considered. It was found

over the welfare-esophoric classmate by four points of I.Q. and 1.1 grades in reading. Thus it appears that when the need for some eye coordination service exists the students who have the least chance of getting it will be the poorest readers regardless of teaching method.

In schizophrenic screening 15% more students having a vertical eye imbalance will fail as compared to students who have a lateral imbalance. Portions of the schizophrenic screens put an extra burden on vertically imbalanced sight.

that the exophoric girls having a laterally diverging sight tendency had the highest average I.Q., were the greatest in number yet their reading ability tested 2.6 grades below the girls whose eyes coordinated perfectly on the near point textbook target. Except for eye coordination testing the problem of those girls would not have been found. After six years of referral on the basis of acuity, eye coordination, clinical mental tests and reading the exophoric girls in the same 14 classrooms were the best readers.

A cross check on the effect of imperfect eye coordination on reading and academic success was done in 1972 with 1049 students in grades 1-10 who were divided into four eye coordination groups. The average group I.Q.'s were equal. The orthophoric, group having the best eye coordination, was the smallest, provided the youngest students in the classrooms and were $101,000 cheaper to educate than their classmates whose eyes tended to deviate 2% or more laterally or 1/2% or more vertically. The orthophoric students had repeated 101 fewer years of class work. A comparison of failures was: orthophoric 6%, hyperphoric 11%, exophoric 12% and esophoric 14%.

When both have orthophoric eye coordination, the average welfare student equals his average non-welfare classmate in both I.Q. and reading tests. However, when both have esophoric eye coordination the average welfare student test five points lower in I.Q. and .95 grades lower in reading. The welfare-orthophoric student has a test advantage

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INTRODUCTION

During 1966 in the Neah Kah Nie School District of Tillamook County, Oregon, the teachers became aware that some vision problems were reducing student success. Neah Kah Nie District was educating 1152 pupils ranging from kindergarten through grade twelve in three elementary schools and high school.

The more obvious learning problems were being attacked through curriculum changes, remedial reading, readability studies of textbooks and tests, and clinical mental tests with supportive mental health care.

Regardless of these efforts a puzzle remained. From 1963 to 1966, test scores had shown that a large block of girls had a greater lag between their I.Q. potential and their academic achievement than had their boy classmates.

Grades four through eight of Bay City and Garibaldi schools contained ten groups of tested students. In each group median the girls suffered a greater gap between I.Q. percentile and achievement percentile than did the boys.

Yet, in five matching groups at Nehalem School under the same tests and the same conditions for the same three years the girls consistently matched or exceeded the boys in closing the gap betwen I.Q. potential and academic achievement.

The girls of the three schools had been screened for vision at twenty feet with the regular school Snellen Visual Acuity Test. The mental and achievement testing had been

administered in all three schools classroom by classroom, boys and girls together under approved conditions by the same experienced tester. The group tests used were Metropolitan Tests of Mental Maturity and the Science Research Associates Achievement Test Battery. Additional Wechsler clinical mental tests were administered for diagnostic purposes to the one-fifth of the students who had achieved the poorest.

Although the studies brought special attention to the Bay City and Garibaldi girls in grades four through eight, little improvement was seen in their gaps between I.Q. and academic achievement during 1964, 1965 and 1966.

The purchase of a commercial vision screener and training in its use revealed additional vision information: acuity at the fourteen inch textbook reading distance; orthophoria, eyes converging easily on the same target; esophoria, eyes tending to over-converge laterally; exophoria, eyes tending to diverge laterally; hyperphoria, eyes tending to diverge vertically.

For the sake of accuracy a double check was done with the vision screener. The Massachusetts Kit provided general "pass" or "fail" eye coordination and Titmus slides provided more accurate measures of alignment tendencies in terms of prism diopters. A prism diopter is the amount of included angle formed by two lines diverging one measure in one hundred measures.

On completion of the new type of vision screening and

new academic testing in 1966, 193 girls of Bay City and Garibaldi had a set of three test scores: eye coordination, I.Q. and reading. With these it became possible to look at vision measures, other than acuity, against a background of I.Q. and reading ability.

The girls' scores were grouped according to their lateral eye coordination tendencies as either orthophoric, esophoric, or exophoric. While these groups showed no significant difference in I.Q. medians, there was a significant relationship between eye coordination and reading ability. Girls having the best eye coordination also had the best reading scores, those having exophoria had the poorest reading scores, and those having esophoria scored in between. (See below)

Group	Type	Number	Percent	Median I.Q.	Median Reading (S.R.A.)
A	Orthophoric	48	25	104	.6 grade above the national norm
B	Esophoric	44	23	102	2.1 grades below group A.
C	Exophoric	101	52	107	2.6 grades below group A.

Whereas the school staff felt secure within the tolerances of the I.Q. and achievement scores, they felt less confident in the sight measures which were outside of the training of teachers.

Dr. William Baldwin, Dean of Optometry of Pacific University, was contacted for help. As a result, in March of 1966, all of the students (1152), including the 193 girls noted above were examined by doctoral candidates in optometry under the supervision of Dr. Richard D. Septon, Director of Clinics. The Modified Clinical Screening technique was used in measuring Snellen visual acuity, pathology, retinoscope, color and cover. This is the same technique as described by ophthamologist Blum and Bettman and optometrist Peters in the Orinda Study published by the University of California Press.

"Cover" is a term for an eye coordination test whereby one eye is concentrated on a target which is temporarily occluded from the other eye by a card. The tester closely observes the occluded eye while removing the card. If no movement is observed the condition is considered as orthophoric. An observation of eye movement up, down, or sideways would mean that the eyes tend not to blend perfectly. The "Cover" test provides a differential diagnosis between conditions like esophoria and esotropia, exophoria and exotropia.

As students completed their eye screening they were met by school counselors who administered visual perception tests. Winterhaven and Frostig forms were used for the younger students and locally devised forms including time pressure for the older students.

This testing revealed students who had erroneous

mental pictures of forms they saw. Some poor readers rotated in their minds the sharper letters or forms as much as ninety degrees (L, K, V, T, W, X, Z).

Although visual perception, the mental component of sight, was then recognized as very important in the act of reading it is not included in this study. Also excluded are acuity and astigmatism.

A difference appeared in the two methods of screening for eye coordination. Only eight of the 193 girls failed the "cover" test of the Modified Clinical Technique. Four tested above reading level and four tested below. Thus there was no significant relationship between the "cover" test and reading ability. However, the diopter measures from the school screener did show a relationship between eye coordination tests and reading. The two tests have different purposes.

In evaluating the local school district's screening method for the 193 girls, Dr. Baldwin stated that it was satisfactory for screening and referral if the proper tolerances were observed. He also stated that the diopter measures of the school screener held closer tolerances than his students could get in the field away from their office equipment.

Thus the matter of orthophoria, esophoria and exophoria stood, somewhat validated for school referrals, but still uncertain about the effect on reading.

However, the Pacific University screening revealed

much which teachers had not known about their students. One student had an atrophying optic nerve; another had central vision burned out from viewing an eclipse; forty had eye infections, one had lashes grooving the eye; others had lazy eyes, opaque particles, ballooning blood vessels, photophobia and undeveloped areas found in the eyes of premature children.

In June 1966, counsellors with aides supported by ESEA Title I informed the parents of 1152 students by letter regarding the passing or failing of eye tests. Recommendations were included for further checking of eye failures by the family doctor, ophthamologist or optometrist. For follow-up purposes, each notice of failure was accompanied with a check sheet of referral completion and date, and a stamped return envelope. School counsellors followed up the more serious eye failures by phone calls and home visits.

Two educational disappointments appeared in the testing and follow-up studies done one year later in June 1967. Only one-fifth of the students with eye failures had been to a doctor. Among the uncared for four-fifths were some extreme cases of girls having 20/200 acuity. And again, for the fourth time, the ten groups of girls in grades four through eight in Bay City and Garibaldi lagged behind their boy classmates in matching academic test achievement to I.Q. potential.

But two years later, the June 1968 studies brought two encouragements. By then two-fifths of the referred

students had been to an eye doctor, and after five years of studies, trials and errors, and testing, nine groups of girls' tests matched or exceeded the boys' tests.

Three years later, in June 1969, results showed that all ten groups of girls' tests showed no comparative lag behind the boys in the relationship of academic achievement to I.Q.

Four years later, in June 1970, test results again showed no comparative lag in the girls.

In March 1971, a diagnostic study was done for the students in the lower achieving third of the tenth grade. Only two were found with uncorrected vision problems. Both had double vision and one had the lowest reading ability of the class though far from having the lowest I.Q. test score. The tenth grade had five years of careful screening, first by Pacific University, followed up with the school screener for new or failing students. Consequently, at this grade level any major problems of learning might not be attributed to neglected eye care.

These experiences with eyesight and reading were causes for pondering. Were the gradual improvements of eye care a mere parallel happening with the improvements of girls' learning? Did the extra attention to girls bring the improvement? Or did a cause and effect relationship really exist between poor reading and some obscure eye coordination factors not detectable with the Snellen test?

We had observed and tested the eye tiring during

reading and writing of over one-hundred left-eyed, right-handed students using flat desks. They produced about twenty percent more on a desk sloped to match the plane of their faces.

Now, would the checking of esophoria and exophoria also reveal eye tiring? Could methods of reducing strain be encouraged which in turn would bring improvements in reading and academic success?

Statement of the Problem:

To what extent do esophoria, exophoria and hyperphoria detract from reading ability?

THE 1972 STUDY

Purpose

Isolate the influence on reading ability produced by orthophoria, esophoria, exophoria and hyperphoria, visual factors outside the scope of the school Snellen Visual Acuity Test.

Organization

A. Staff

A project director, a guidance para-professional qualified to operate a vision screener, three counsellors for academic and mental testing, two secretaries for gathering and arranging data, one university level vision consultant, one practicing optometrist as occasional evaluator of school screening methods and tolerances, and an advisory committee designed to insure that no physical, emotional or social harm would come to human subjects of research.

B. Subjects

All elementary students of Bay City, Garibaldi and Nehalem schools and secondary students of Neah-Kah-Nie High school consisting of all in grade nine and the lower achieving half of grade ten. In grades one through ten 1049 students were screened for eye coordination. They were 99% white Americans and 1% from Indian or Japanese ancestry. No patients of eye doctors were included for they were already receiving the services this screening might suggest for them.

C. Equipment

One commercial vision screener, a calculator, a mimeograph and typewriters.

D. Materials

Computer cards, size 4"x 5", gummed labels printed with students names, numbers, school and grade, and mimeographed sheets for compiling data (8-1/2" x 14").

Procedure

A. Vision Screening

The guidance para-professional screened the 1049 students during the 1971-1972 school year.

B. Data Assembly

At first one secretary was hired to prepare data cards, and search and compile data from students' records. OTIS, an Oregon agency which computes student attendance data, furnished for each student a gummed, printed label bearing the student's name, number, school and grade.

The data card was designed for handy entry, sorting, and retrieval of data with spaces across the top for: I.Q. test type and scores from 70 to 140; down the right side, reading test level of April 1972, age, hyperphoria and eye-hand mixed dominance; on the bottom, sex, orthophoria, esophoria and exophoria. After mimeographing this design on the data cards the name labels were stuck on the upper left corners.

The work then grew to such an extent that a second secretary was required.

For entry of data, the cards were arranged by schod

by grade and by student in alphabetical sequence.

For retrieval of data, the cards were sorted into four major categories: orthophoric, esophoric, exophoric and hyperphoric, but still retaining the previous order. Many of the students had imbalance both vertically and horizontally such as esophoric-hyperphoric or exophoric-hyperphoric. It was decided to include only those students who had clear, single factors.

C. Test Data

The reading test results were taken from the Stanford Achievement test battery administered in March and April of 1972.

The group I.Q. test results are from the California Tests of Mental Maturity for all students above grade three. About thirty-five percent had a clinical test to help solve a problem, either a Wechsler Intelligence Scale for Children or a Stanford Binet. Whenever a student had both group and individual tests the latter score was used.

The vision screening data were gathered in the 1971-1972 school year. For this study only these are recorded; orthophoria, diopters of esophoria, exophoria and hyperphoria. Ninety-four students had both vertical and lateral sight deviations. When these were excluded for the sake of clarity 955 students remained with uncomplicated eye coordination measures.

RESULTS

A. A 1966 and 1972 Compartive Study of Girls of Bay City and Garibaldi, Grades Four through Eight.

Previous to 1966 the girls had no general vision screening except with the teacher administered Snellen Visual Acuity Test. The 1972 girls, however, except for grades four and five, had a vision screening with the Modified Clinical Vision screening technique done in 1966 by the Pacific University College of Optometry. All the 1972 girls also had a yearly checking done with a commercial vision screener by a trained guidance para-professional under the supervision of the guidance director.

In 1966 the reading ability of the average orthophoric girl was 2.1 grades above the esophoric girl and 2.6 grades above the exophoric girl.

In 1972 after six years of vision checking with eye coordination included and referral the reading test deviations from the national norm were almost the same: orthophoric girls -.59, esophoric -.58 and exophoric -.54 grades.

The number of 1972 girls dropped to about one-half of the 1966 girls partly because those having both vertical and lateral problems were excluded. The girls of greatest concern improved: the esophoric about one grade and the exophoric about one and a half grades. Part of the benefit may be attributed to ESEA Title I services extended only to the girls who were achieving one or more years below their grade

level. This included very careful eyesight checking and referral, visual perception testing and training and summer clinics.

Two differences in measurement are seen.

1. The esophoric measures of 1966 ranged from two to twelve diopters lateral eye over-convergence and the exophoric, two to fourteen diopters lateral eye divergence. But the differences in eye pointing in 1972 were only two to seven diopters for esophoric and two to seven for exophoric. Thus, the extreme divergences beyond seven diopters are no longer present. The average deviation now is three and four-tenths diopters for both esophoria and exophoria.
2. In 1966 all esophoric and exophoric measures were taken regardless of presence of some hyperphoria mixed in. In 1972 any mixtures of hyperphoria with esophoria or exophoria were not included. This partly accounts for the fewer numbers of girls in 1972 in these two categories.

In 1966 the I.Q. scores of the three sight types were about equal, but there was a wide difference in reading scores. In the same 1972 vision types the I.Q.'s were again about equal, but so was the reading. Thus it may be reasoned that the efforts to reduce the tiring effect of esophoria and exophoria had resulted in normal reading and academic test scores for the girls.

Table I

A COMPARISON OF 1966 AND 1972 TESTS:

THREE SIGHT MEASURES, READING AND I.Q.

DONE FOR THE GIRLS OF BAY CITY AND GARIBALDI

GRADES FOUR THROUGH EIGHT

Year	Sight Conditions	Diopters Deviation	Number of Girls	Percent	I.Q.	Deviation from Reading Norm
*1966	Orthophoria	None	48	25	104	+ .60
1972	Orthophoria	None	18	27	104	- .59
1966	Esophoria	2 to 12	49	23	102	-1.50
**1972	Esophoria	2 to 7 (av. 3.4)	35	32	105	- .58
1966	Exophoria	2 to 14	96	52	107	-2.00
**1972	Exophoria	2 to 7 (av. 3.4)	55	51	103	- .54

*Tolerances from one diopter esophoric to one diopter exophoric were allowed in orthophoria.

**In 1972 two kinds of girls do not appear, those who had a mixed sight condition either esophoria-hyperphoria or exophoria-hyperphoria, and those girls not tested because they were receiving professional vision services.

B. Detection of Sight Failures

The 1966 vision tests done by doctoral candidates using the Modified Clinical Technique were reviewed. In 222 cases the Snellen Test alone indicated at least one sight failure. However, in 159 cases having problems, the Snellen did not detect any sight failures. These were found by other tests or observations.

The Snellen was the most accurate single screening test in detecting fifty-eight percent of sight failures, but forty-two percent of the visually handicapped students would have been overlooked if the Snellen had been used to the exclusion of other tests.

Thus Oregon teachers and nurses who are limited to the Snellen Test may fail to refer for help forty-two percent of children who are handicapped in reading because of sight problems.

C. Orthophoric Students

The orthophoric group is remarkable in its freedom from negative learning factors. This group is the youngest, has the least eye direction strain, has the least referrals for learning problems, the fewest repeaters and has had the least Title I supporting service. Although I.Q. is one point lower than other groups, reading is above district average. This group promises to be the most economical to educate, costing fewer dollars for the school district, and fewer years for the students.

The tolerances used in classifying this group were:

hyperphoria, none; esophoria, one diopter; and exophoria, one diopter.

Table 2

ORTHOPHORIC STUDENTS

(Having perfect vertical and lateral balance)

Grade	No.	Median Age	Median I.Q.	Median Reading Test	Average Reading Deviation
1.6	14	6-7	---	1.5	- .1
2.6	14	8-4	---	2.3	- .3
3.6	8	9-3	---	3.9	+ .3
4.6	12	10-0	103	3.7	- .9
5.6	10	11-0	102	4.2	-1.4
6.6	10	11-11	106	5.2	-1.4
7.6	7	12-8	110	7.0	- .6
8.6	13	14-2	103	7.8	- .8
9.6	3	14-9	99	7-8	-1.8
*10.6	3	15-11	95	7-2	-3.4
	Total 94				Median Deviation - .59

*The only tenth graders tested were the slower learners, about 50%.

D. Esophoric Students

This group of 135 esophoric students is the oldest. Although having had the most time in school, its reading level ties for bottom place with hyperphoric group.

The heavy influence of over-age students comes from fourteen percent of late-started or retained students as follows: grades 1 (5), 2 (3), 3 (0), 4 (2), 5 (9), 6 (4), 7 (15), 8 (0), 9 (0), 10 (0).

No over-age esophoric students remain in grades eight, nine and ten.

The median deviation tendency for these esophoric students is no diopters vertically and 3.4 diopters over-converging laterally. The span of lateral deviation ranges from two to seven diopters.

Table 3

ESOPHORIC STUDENTS

(Having the tendency

for the eyes to over-converge, but not cross)

Grade	No.	Median Age	Median I.Q.	Median Reading Test	Visual Deviation Diopters	Average Reading Deviation
1.6	10	7-4	---	1.5	3.8	- .1
2.6	4	8-0	---	2.3	4.0	- .3
3.6	13	9-0	---	3.6	4.8	.0
4.6	12	9-9	101	4.0	3.6	- .6
5.6	21	11-4	103	5.0	3.5	- .6
6.6	15	12-2	106	5.6	3.7	-1.0
7-6	20	12-10	107	6.5	3.6	-1.1
8-6	21	13-11	104	8.0	3.5	- .6
9.6	15	14-11	104	8.1	3.3	-1.5
*10.6	4	15-11	101	8.9	2.5	-1.7
	Total 135					Median Reading Deviation - .74

*The only tenth graders tested were the slower learners, about 50%.

E. Exophoric Students

It sometimes seems that exophoria is a natural condition best suited for vigorous large scale activity but less suited for close reading effort. When eye coordination was first measured in 1966 most of the girls in fourteen classrooms of Bay City and Garibaldi were found to be exophoric. This large proportion seemed to suggest that exophoria was the most standard eye coordination condition. The eyes of these girls tended to diverge laterally from two to fourteen prism diopters. Although these girls had the highest average I.Q. test score they also had the lowest average reading test score.

By 1972 the exophoric students had six years of testing for both eye coordination and reading. Those who had the combination of large exophoric deviations and poor reading were referred for professional eye care.

The exophoric deviations ranged from two to seven diopters with a median of 3.4. Thus the extreme deviations between eight and fourteen diopters had been eliminated.

These 1972 exophoric students have the highest average reading score. They almost match the orthophoric students in youngness in the classrooms, the least retentions and average only $30 more per year to educate. However, in over six years this group had the most ESEA Title I support because their academic testing placed them in the highest priority as educationally disadvantaged.

Table 4

EXOPHORIC STUDENTS

(Having the tendency for eyes to diverge laterally)

Grade	No.	Median Age	Median I.Q.	Median Reading Test	Visual Deviation Diopters	Average Reading Deviation
1.6	38	7-1	---	1.5	2.9	- .1
2.6	38	8-1	---	2.6	3.6	- .0
3.6	40	9-0	---	3.5	3.5	- .1
4.6	35	10-2	103	3.9	3.2	- .7
5.6	43	11-0	103	4.9	3.3	- .7
6.6	41	12-1	103	5.9	3.3	- .7
7.6	35	12-11	102	6.4	3.4	-1.2
8.6	40	14-0	104	7.6	3.1	-1.0
9.6	21	14-11	104	8.6	3.3	-1.0
*10.6	8	15-11	100	9.1	.5	-1.5
	Total 339				Median Exophoria 3.4 (2 to 7)	Median Reading Deviation - .44

*The only tenth graders tested were the slower learners, about 50%.

F. Hyperphoric Students

This hyperphoric group of 457 students is the most numerous and ties with the esophoric group for the lowest place in reading, though having normal I.Q. This group is numerically large because the vertical measure used is small, only half a diopter, usually considered not significant. However, it appears to be significant to reading ability.

Eleven percent of the hyperphoria group are a year older, placing them next to the esophoric group in late-started or retained students. They tend to show the longest range of over-age with frequency as follows: grade 1 (11), 2 (11), 3 (7), 4 (5), 5 (7), 6 (11), 7 (5), 8 (0), 9 (5), 10 (10). The vertical deviation ranged from .5 to 1.1 diopters with a median of .59 diopters. None having lateral deviations were included.

Fifteen percent more hyperphoric than combined esophoric and exophoric students are revealed as "distractable" by clinical mental tests. The eye exercise demanded in the Wechsler Coding subtest is particularly difficult for students having vertical eye deviation problems.

Thus it may be that fifteen percent of vertically divergent children are unnecessarily taking medication to reduce their classroom distractability. While some pass the acuity test compensating lenses to reduce the vertical divergence may reduce classroom frustration.

Vertical eye imbalance affects the scores and interpretation of the Wechsler Intelligence Scale for Children.

When subtests Digit Span and Coding are relatively low, reading will also be low. Teachers expect no higher reading ability than the combined maturity level of Digit Span and Coding. Both tests demand memory and concentration. When both are low an emotional problem is suspected.

However, the Coding test also demands a visual capability in three up and down visual tasks: identifying a number on one level, finding its code on a higher level then recording it on a lower level. This job is most difficult for students having vertically imbalanced sight as follows:

Type of Visual Imbalance	Number of Students Having Wechsler Tests	Suspected Emotional Problems	
		Number	Percent
Vertical (Hyperphoric)	317	178	39
Lateral (Esophoric and Exophoric)	474	116	24
Total	791	Difference	15

It appears that the fifteen percent greater proportion of emotional suspects is not from emotional trouble, but rather from their hyperphoric difficulty of up and down visual adaptation.

If correction of vertical visual imbalance can raise a student's Coding score to normal, then the diagnostic pair, Digit Span and Coding, will be broken and the term "emotional suspect" will be no longer valid for that student.

Thus vertical eye imbalance weakens the Coding score,

and as a weak score it is used as one indicator in three schizophrenic screens:

The Wechsler Schizophrenic Screen

The Rabin's Schizophrenic Index

The Wechsler "3 x 3" Schizophrenic Screen

Thus a vertical visual imbalance may mislead helping services away from real causes, and prevent them from giving available and effective help.

Table 5

HYPERPHORIC STUDENTS

(Having the tendency

for one eye to aim higher than the other)

Grade	No.	Median Age	Median I.Q.	Median Reading Test	Visual Deviation Diopters	Average Reading Deviation
1.6	43	7-2	---	1.5	.62	- .1
2.6	43	8-2	---	2.3	.58	- .3
3.6	44	9-1	---	3.5	.52	- .1
4.6	55	9-10	104	3.9	.65	- .7
5.6	68	11-0	103	4.9	.59	- .7
6.6	54	12-1	104	5.6	.51	-1.0
7.6	51	13-0	105	6.5	.62	-1.1
8.6	59	13-11	103	7.5	.52	-1.1
9.6	30	15-1	103	10.0	.67	+ .4
*10.6	10	15-11	98	8.9	.54	-1.7
	Total 457				Median Hyperphoria .59	Median Reading Deviation - .74

*The only tenth graders included were those tested for slower learning, about 50%.

Table 6

READING DEVIATIONS AFTER SIX YEARS OF INCLUDING EYE COORDINATION IN SCHOOL VISION SCREENING

Type	No.	Median Age	Median I.Q.	Median Reading Grade	Median Sight Deviation	Median Reading Deviation
Orthophoric	94	10-4	102	4.0	none	-.59
Esophoric	135	12-4	104	5.4	3.4	-.74
*Exophoric	339	11-0	103	4.6	3.4	-.44
Hyperphoric	457	11-11	103	4.8	.59	-.74
Mixed (Vertical and Lateral Deviations, 9th grade)	24	14-11	103	8.3	(vert. .5) (lat. 3.0)	-1.30

Total 1049

* Students who have had the most E.S.E.A. Title 1 support because they showed the most disadvantage in reading and academic tests.

G. Time and Money Loss From Eye Fatigue

A quotation from Dr. Richard Septon will serve admirably to introduce this topic. "The child with a heterophoria (esophoria, exophoria or hyperphoria) is not necessarily in trouble, but the notion is that he must expend some energy in dealing with his imbalanced tendencies...he must fight a bit harder to hold things clear and single than his "balanced" classmates. The magnitude of the 'phoric deviation will determine how hard he must fight up to some point at which the reserves are not adequate to cope with the problem and he either gives up two-eyed functioning and becomes a manifest strabismic, or he gives up his close work and settles for the easier, far point seeing".

With I.Q.'s equal, twice the proportion of visually imbalanced students have repeated grades than have visually balanced (orthophoric) students. This suggests that many more than supposed are finding close work too difficult. By applying $1,000 of extra cost to each extra student year, the district had paid $101,000 more for the esophoric, exophoric, and hyperphoric students than for the "balanced" orthophoric students. The three imbalanced types have spent 101 more years in duplicated work by median grade level 5.6, not half way through school.

Table 7

EXTRA COST OF EDUCATION

ESOPHORIC, EXOPHORIC AND HYPERPHORIC STUDENTS

Condition of Eye Coordination	Total Compared	Number of Over-age Students	Percent Over-age	Added Cost at $1,000 per Extra Student Year
Perfect Eye Direction (Orthophoria)	94	6	6	$6,000
Lateral Diverging (Esophoria and Exophoria)	474	57	12	$57,000
Vertical Diverging (Hyperphoria)	457	50	11	50,000
Total	1025	113		$6,000 107,000
				Extra Cost $101,000

Table 8

RELATIVE COSTS PER YEAR OF EDUCATING

ORTHOPHORIC, ESOPHORIC, EXOPHORIC AND HYPERPHORIC STUDENTS

Type	Description of Tendency	Medians Age	I.Q.	Reading	Cost	Comment
Orthophoric	perfect eye coordination	10-4	102	- .59	$1060	Youngest in the class-rooms with least failures
Exophoric	laterally diverging	11-0	103	- .44	1090	Had most Title I help
Hyperphoric	vertically diverging .5 or more diopters	11-11	103	- .74	1110	
Esophoric	laterally over-converging	12-4	104	- .74	1140	Oldest with most re-peaters

Reading failures appear related to uncared-for visual imbalance. Orthophoric students, whether rich or poor, have perfect eye coordination and thus need no such care. The proportion of orthophoric, adequate income students to orthophoric, *low income students is 74% to 26%. These orthophoric low income students are remarkable in being equal to the adequate income students in freedom from visual imbalance, in 103 I.Q. potential and in reading ability.

The exophoric students have a laterally diverging sight tendency. Their proportion of adequate income to low income is 78% to 22%. Their respective I.Q.'s are 103 and 102. Thus the low income, exophoric child has equal mental potential but is less likely to have had attention for his visual imbalance. By age 11-0 he has a reading disadvantage of .3 grades below his classmate who also has the exophoric tendency but adequate income.

The esophoric students have a laterally over-converging sight tendency. Eighty-five percent are on adequate income and 15% on low income. Respective I.Q. relationship is 104 to 99. By age 12-4 the low income, esophoric student is reading .95 grades below his adequate income, esophoric classmate and 1.1 grades below his younger, low income, but orthophoric (perfectly coordinated) classmate above.

*Low income children on welfare, free or reduced school lunch or Tillamook County administered U.S. free food program.

Thus it appears that regardless of philosophies of the four schools involved, the spread of ten grade levels, the various methods of teaching reading, the levels of I.Q. or financial ability those students who have perfect eye balance are most successful in school, and those students who are most denied diagnosis and care for needed eye coordination help remain to suffer as the poorest readers.

Traditionally only the acuity test and observation have been permitted for use in the education profession. While the acuity test is the best single vision screening test it is not designed to cover the whole field of sight problems. In the school population of 1152 it failed to detect forty-two percent of students having sight problems.

Teachers who record vision as "pass" on the basis of the acuity test alone actually record an error for the undetected forty-two percent of students. By omitting other screening tests they may effectively close the door on help to these students.

The students having multiple eye coordination problems were excluded from the study. These students had to make both vertical and lateral adjustments to read at the fourteen inch textbook distance. The two kinds of data did not combine simply together for comparison against reading ability. A vertical imbalance appeared to reduce reading five or six times as much as the same amount of lateral imbalance. Twenty-four ninth graders had mixed vertical and lateral measures. Their ages averaged a normal fourteen

years and eleven months and their I.Q.'s averaged a normal 103. Their deviations were .5 diopters vertical and 3.0 diopters lateral. Their reading level at grade 9.6 was 1.3 grades below the national norm.

The eight students who had given up on two-eyed sight showed no average disadvantage in reading ability. They had less strain when reading since they no longer accepted the challenge of getting both eyes together on the same reading target. However, 931 students who used both eyes together at the fourteen inch test and textbook reading distance were poorer readers. They tired under the sustained effort required to overcome tendencies of esophoria, exophoria or hyperphoria. They repeated twice as many grades as their orthophoric classmates.

CONCLUSIONS

In the case of reading instruction this study shows that vision testers who limit their testing to the acuity test do a service for 58% of visually handicapped children, but a disservice for the 42% of visually disadvantaged that the acuity test does not detect, leading to a wrong diagnosis of reading problems.

Reading-eye coordination connections are not discernable in students tested only for visual acuity.

The "Cover" test serves the eye doctor as a useful diagnostic tool. Although it is used in checking school children, as in the Orinda, California school study, it may lead parents and teachers to a false belief that "all is well". The "Cover" test does its diagnostic job well, but it contributes little, if anything, to the improvement of teaching of reading or to the improvement of the student's reading.

The Massachusetts School Vision Kit was used as a cross check of each student in this study. Its "pass" or "fail" designation with built-in tolerances is very rough, leaving the tester with much coarser data than he gets from perceptual, psychological and all educational tests. The finer degrees of visual imbalance or mixed imbalance cannot be read from it, tending to leave students with reading problems less understood by principals, teachers and counsellors.

For reading purposes a much more useful tool is the kind used in industry that provides measured units of eye

deviation. With results from such a tool a teaching staff can know their disadvantaged students better and either refer or compensate for special difficulties. Two examples that provide measures in terms of prism diopters are the Keystone Visual Survey Telebinocular and the Titmus Vision Screener.

The orthophoric students have the most perfect eye coordination, are relatively few in number, have average I.Q., are the youngest in the classrooms, have the least failures and are the most economical to educate.

The esophoric students were previously considered the best readers because their eyes converged most easily on near point tasks, but the esophoric students in this study include the most over-aged students who appear to drop out in grades eight, nine and ten.

The hyperphoric students who tend to have one eye aim higher than the other are among the oldest and poorest readers in the classrooms although having I.Q.'s equal to other groups. Also, hyperphoric students are fifteen percent more subject to a wrong diagnosis as "emotionally distracted" from schizophrenic screening and may be unnecessarily medicated. Their vertical eye imbalance interferes with their success in performing a psychological test that is included in three schizophrenic screening instruments.

The exophoric students having laterally diverging sight are usually the poorest readers. However, when those having excessive deviations were relieved in six years time by professional vision services and special helps this group re-

sponded very well and became the best reading group. These exophoric students had received the most Title I services because their great reading lag had put them in the highest priority for help.

Patience is needed over several years time to improve students' sight-sensory ability to learn. Referrals by letter, by phone and by home visits to parents, all combined, do not appear to achieve more than twenty percent of corrections per year. Results in this study began to show in the third year. Students whose eyes deviate from perfect coordination fail twice as frequently, and because they are so numberous their extra years of instruction are costly in students' time and taxpayers' money. Among 1025 students tested, the poorer eye coordinated students, although equal in I.Q., cost $101,000 more and duplicated 101 more years of study by median grade 5.6, not quite half way through school.

Before eye coordination help was effective, girls' reading ability was good, poor and bad in the order of orthophoria, esophoria and exophoria and with no relationship to I.Q. After six years of attention to eye coordination, girls' reading was respectively good, good and good not according to eye coordination, but according to ther equal I.Q. scores. Thus reduction of eye coordination problems does increase the sustained effort on reading.

Author's opinions are expressed from a base of twenty four years of responsibility for the improvement of learning as an educational advisor for the Civilian Conservation

Corps, a superintendent, a principal, a supervisor of nine high schools, a curriculum director and a director of testing, guidance and research.

1. Fifteen percent of reading difficulty may be assessed to the lack of recognizing the students' eyesight strains while under sustained effort at the test and textbook reading distance.

2. A diagnostic educational tool will be developed whereby age level limitations of reading may be interpreted from data of esophoria, exophoria, hyperphoria and their combinations. This will be a companion tool to others that already establish that a student, regardless of I.Q., will not read any higher than his age level of memory, concentration or visual perception.

After their vision resource levels are better appreciated, students will be put into better visual shape to learn independently from reading and teachers will more wisely assign methods, materials, environment and test types to assure maximum growth.

RECOMMENDATIONS

Early in each child's school life furnish him three vision supports:

1. a careful clinical vision check-up
2. a record of near and far acuity, pathology, diopters of visual deviations, ophthalmoscope and color described in layman's language for his school file
3. recommendation to reachers how uncorrectable visual conditions may be compensated for in the classroom to improve efficiency.

Hire and train a school-oriented para-professional person to screen each year for acuity at twenty feet and book reading distances, vertical and lateral balances, depth perception, left-right dominance of eyes and hands and visual perception with Winterhaven or Frostig tests in the early years.

This person would refer visually disadvantaged students, follow-up with the eye doctor, the parent and the teacher and keep a record of tests, referrals and events.

Excellent screening, referral, and follow-up have been performed by mothers having teacher, secretarial or nurse's training, at a cost of about $3.00 per student per year.

In cases of hyperphoria, have all clinical testers use a sloped easel to reduce the effects of vertical imbalance

when giving the Coding portion of the Wechsler Test.